
GeoDTC
Geo spatial Data & Technology Center
Bahir Dar University

Research Thematic areas

Introduction

In an aim to contribute both to the practical concerns of people in an immediate problematic situation and to further the goals of sustainable natural resources use, the Geo-Spatial Data and Technology Center (GDTC) identified thematic research areas which will be conducted in cooperation with various stakeholders. Thus, the dual commitment here will be to study the natural resources system mainly in the Abay River basin and concurrently to collaborate with members of the system in changing and/or modifying it in what is together regarded as a desirable direction.

Motivation

The motivation to identify the issues for research themes arises from the fact that various development works are being undertaken and a lot are yet to come. These works affect the environment in one or another way. On the other hand the development works are also subject to various environmental processes. The study on the functioning of the implemented systems and a contribution on their better functioning will be an important contribution to ensure sustainable use of the natural resources in the Blue Nile region when our university is situated. There are various issues to investigate and suggest a different way of doing them so as to get a better output. Resources (financial and technical) are also committed by BDU for use in collecting primary data, organizing a database for use in the future, analyzing data and presenting the output for decision makers. Twining research efforts of higher academic institutions with implementing offices will also result in increased benefits by avoiding redundant investment on research activities, creating an environment to effectively address outreach issues and build the capacity of partners.

Partners

Partnership will be open to other interested implementers and academic institutions (local and international).

The GDTC work team had conducted a work series of meetings since August, 2013 and deliberated on the research thematic areas that the center will focus. The ranking criterion are also discussed and decided. Consequently four thematic areas are identified. These are:

1. Resource mapping
2. Disaster Risk Reduction and Food Security
3. Environmental monitoring and modeling and
4. Suitability analysis

The ranking was made according to their importance based on the following four rating criteria:

- Whether it is a policy priority or not(ranked 1st and given a value of 4)
- Whether its output is applicable or not (ranked 3rd and given a value of 3)
- Whether it is a problem or not (ranked 2nd and given a value of 2)
- Whether it is doable or not (ranked 4th and given a value of 1)

Finally the priority matrix of all the themes is prepared and priority ranks are given based on the sum of the values given.

Table 1: Priority matrix of research themes

	Theme	Policy issue	Problem issue	Applicability	Do-ability	Total	Rank
RESOURCE MAPPING							
1	Soil mapping	4	4	4	2	14	3
2	LU/LC mapping	4	3	4	4	15	1
3	Wetland mapping	2	3	2	4	11	5
4	Energy mapping	3	4	3	3	13	4
5	Ground & Surface Water mapping	3	2	2	2	9	7
6	Soil moisture mapping	2	3	2	2	9	7
7	Mineral resources mapping	2	2	4	2	10	6
8	3D Cadastral mapping	4	4	4	3	15	1
DISASTER, RISK AND RELIEF							
1	Flood	4	4	4	4	16	1
2	Drought	4	4	4	4	16	1
3	Dust	2	2	2	4	10	4
4	Land	2	2	2	2	8	8
5	Fire	1	2	2	4	9	7
6	Conflict	4	3	3	4	14	3
7	Pest	2	2	3	3	10	4
8	Malaria	2	2	3	3	10	4
ENVIRONMENTAL MODELING							

1	Invasive species	2	3	2	2	9	8
2	Contaminant	3	3	2	2	10	6
3	Impact	3	3	3	3	12	3
4	Soil remediation	2	3	4	2	11	5
5	Waste management	2	4	3	3	12	3
6	Infrastructure	4	3	3	4	14	1
7	Geoid	1	3	2	2	8	9
8	Traffic	3	3	3	4	13	2
9	Wetland ecosystem	2	3	2	3	10	6
SUITABILITY							
1	Irrigation	4	4	4	4	16	1
2	Crop	4	4	3	4	15	2
3	Water harvesting	4	4	2	4	14	3
4	Energy harvesting	3	3	2	2	10	5
5	Tourism	3	3	3	4	13	4

Table 2: Research themes

Rank	Sub-themes
Theme 1: Resource mapping	
1	Land Use Land Cover Dynamics
1	3D Cadastre and Property registration
3	Soil Mapping
4	Solar and wind energy mapping
5	Wetland mapping
6	Mineral resource mapping
7	Soil moisture mapping
7	Ground and surface water mapping
Theme 2: Disaster Risk Management and	
1	Flood hazard prediction and
1	Drought risk assessment and
3	Conflict management
4	Dust storm prediction
4	Pest monitoring
4	Identification of malaria prone areas
7	Forest fire detection and prediction
8	Land slide prediction and mapping

Rank	Sub-themes
Theme 3: Environmental monitoring and	
1	Infrastructure accessibility modeling
2	Traffic accident modeling
3	Waste management
3	Program and project impact
5	Soil remediation
6	Contaminant modeling
6	Monitoring and modeling wetland
8	Monitoring and mapping invasive
9	Geoid determination
Theme 4: suitability analysis	
1	Suitability analysis for irrigation
2	Suitability analysis for specific type of crop
3	Suitability analysis for water
4	Tourist attraction site mapping
5	Suitability analysis for energy

Theme 1: Resource mapping

- **ENVENTORY, MAPPING, MONITORING AND MODELLING OF WETLAND ECOSYSTEMS**

Globally, wetlands are under pressure due to a rapid rising demand for freshwater and fertile lands. This leads to modification of wetlands ranging from various stages of degradation to irreversible loss. Spatial information has been propagated and is increasingly used for wetland management and conservation in developed countries. The wealth of existing spatial information, however, is not optimally suited to serve this purpose. Firstly, existing maps appear to be notoriously poor when it comes to the localizing extent and describing degradation status of wetlands. Secondly, there is a lack of spatial information on wetland hydrology. Finally, existing spatial information remains static. Addressing the problems of wetland management requires a dynamic view of the changes in hydrology and land use and how these affect the status of the ecosystem.

The UN Millennium Ecosystem Assessment determined that environmental degradation is more prominent within wetland systems than any other ecosystem on Earth. International conservation efforts are being used in conjunction with the development of rapid assessment tools to inform people about wetland issues.

The accurate mapping and classification of wetlands is crucial for their sustainable management. Various remote sensing tools are available to discriminate water dominated vegetation and can be employed to map wetlands. The maps should however be validated through an extensive field verification. A consistent database design should also be devised to store wetland information so that users can easily retrieve them and other databases can be easily linked to them.

The wetlands around Lake Tana are endangered because of different factors. Expansion of irrigation activities is one factor affecting them. Researchers are to examine and identify the driving factors for wetland degradation and model the effect on hydrology and ecosystem.

Expected outputs

- Develop novel remote sensing and GIS techniques to improve mapping and monitoring of wetland ecosystems.

- Develop spatially explicit dynamic models to allow simulation of the behaviour of a freshwater wetland ecosystem.
- Development of a model, which allows predicting the hydrologic and biotic responses of this ecosystem to modifications in upstream hydrology.
- Scientific remedial actions proposed

Outreach

- Preparation of systems how concerned bodies could intervene in the specific area
- Awareness creation through workshops and seminars about the risks paused on wetlands and possible remedial actions.

Evaluation

- The output of the research would be evaluated by the examining the effort made to convince concerned bodies to get in to action.
    - The recommendations made should be practical at the specific area under investigation.

• SOIL MAPPING

Digital Soil Mapping is the creation and the population of a geographically referenced soil database. It is generated at a given resolution by using field and laboratory observation methods coupled with environmental data. Digital soil mapping is advancing on different fronts at different rates all across the world. There should be a system to explore strategies for bridging research, production, and environmental application of digital soil mapping.

An intimate knowledge of the kind of soils their spatial distribution is a prerequisite in developing rational land use plan for agriculture, forestry, irrigation, drainage etc. Soil resource inventory provides an insight into the potentialities and limitation of soil for its effective exploitation. Soil survey provides an accurate and scientific inventory of different soils, their kind and nature, and extent of distribution so that one can make prediction about their characters and potentialities.

For many applications of modeling environmental conditions or developing scenarios for environmental change analysis, information on soil characteristics forms a vital component. Evaluations of the status of environmental conditions or modeling dynamics very often have a spatial dimension. This spatial dimension is required in the study of processes which include movements across a land surface, like soil erosion, or for which change statistics are required, such as transition matrices.

Attempt should be made to position the soil typological units within the spatial units. Previous approaches in mapping soil attributes to the spatial layer either restricted the values to the dominant typological unit or used general settings applied to all spatial and typological units of the database. In this research each unit of soil should be recorded along with its ancillary data.

The soil digital data that most researches could access is FOA soil data produced at 1:1,000,000 scale. This is a very rough scale and should not be taken as reliable particularly for smaller areas. Therefore, there should be mechanisms to start producing databases and digital soil maps in 1:25,000 scale maps for a specific model watershed using grid or another system.

Expected output

- Prepared soil map on 1:25,000 scale for a model watershed.
- Delineate soil mapping units using uniform legend.
- Developed soil geodatabase for the specific watershed.

Outreach

- The output is/are going to be taken as model for soil mapping in the university and could be taken as teaching aid.
- Printed maps should be given to concerned bodies at woreda and kebele level (at least two prints in A_0 size)

Potential implementer

- CAES
- Regional Agriculture bureau

Evaluation

- The output will be evaluated by team of experts whether it fits at the ground or not and follows scientific approach.

- The geodatabase could be evaluated for its standard.

- **SOIL MOISTURE AVAILABILITY MAPPING**

Estimation of soil moisture in the root zone is important for hydrological modeling, monitoring photosynthesis and plant growth, and estimating the terrestrial carbon cycle. Timely estimates of soil moisture are also important for contributing to the forecasting of hazardous events such as floods, droughts and heat waves.

Soil moisture is generally mapped based on precipitation and temperature, because the network of instrumentation to measure soil moisture is very sparse. An established model may be used to map soil moisture. The model takes observed precipitation and temperature and calculates soil moisture, evaporation and runoff. The potential evaporation is estimated from observed temperature.

Soil moisture sensor probes enable precise low cost monitoring of soil water content. New smart technologies are available for soil monitoring. These sensors log precise moisture measurements and transmit the data to a remote station via a wireless network. One a grid of such sensors are installed in an irrigated field these provides the capability to precisely monitor moisture levels and hence help to properly plan irrigation schedules. Controlling moisture levels precisely helps in maximizing water productivity and avoiding soil salinity by reducing excessive water supply to an irrigated field.

Expected output

- Soil moisture map for a selected irrigation scheme

Outreach

- Soil moisture monitoring for medium scale irrigation scheme

Potential implementer

- Abay River Basin Authority
- Regional water resource development bureau

Evaluation

- Reliability of the maps for irrigation planning

- **Land Use Land Cover Dynamics**

Mankind's presence on the surface of the earth results in the modifications of landscape. This modification largely occurs through land-use/cover changes and can have adverse impacts and implications on the local, regional and global environments. It is an endlessly changing process taking place on the surface of the earth and mainly caused by the processes of expansion of agricultural, settlement and grazing lands and the removal of vegetation.

LULCC arises by virtue of complex interactions lead to unexpected feedbacks and ecological impact beyond the boundaries of direct human use of the land. Conversion of agricultural land cover creates widespread ecological disturbance.

Mapping land use/land cover (LULC) and detecting the change using remote sensing and GIS techniques is an area of interest attracting concerned experts and organizations. To understand how LULC change affects and interacts with the earth systems, information is needed on what changes occur, where and when they occur, the rates at which they occur, and the social and physical forces that drive those changes.

Expected results

- Information on long-term Land Use Land Cove Dynamics mapped
- Future scenario of the land use land cover is predicted
- Identification of driving factors for the dynamics
- Proposed scientific remedial actions

Outreach

- Woreda and kebele officials in the respective areas are to be introduced about the case and advised and supported for remedial actions
- Afforestation program will focus on area indicated as degraded from the result of the research

Potential implementer

- Bureau of Agriculture, Forest enterprise and their line offices
- Woreda agriculture office and NGOs (if available in the woreda)
- Kebele development agents and concerned bodies at kebele lelevel.

Evaluation

- The result of the research will be evaluated for its accuracy at local level.
- The result of the research will also be evaluated whether the recommendations are made based on the socio-economic and cultural conditions of the local community.

- **3D Cadastral and Property registration**

Real property in the physical world is in three dimensions. In Ethiopian history there are cadastral system but the system have 2D cadastral system. It means that the 3D cadastre doing the cadastre works at three-dimensional .However; generally the three-dimension (3D) has been not yet started in Ethiopia up today. In general this problem solves by making the elevations project of the engineering constructions. Today, the digital cadastre works only provides that obtain the 3D of the parcel corners. It can be accepted that this process is one of the most important development of 3D cadastre. Therefore, the main needs are that make all the cadastre parcels' elevation or buildings on the parcel.

Expected output

- Apartment units in the building or residence 3D registration System
- Apartment units and with land registry
- Apartment units and cadastral registration
- registered property in 3D dimension

Outreach

- For different purpose government can use for tax collection, proper administration of the property.
- to keep security of the property

Potential implementer

- MoA, BoA, Bureau of Urban Development
- Bahir Dar University

- **GROUND AND SURFACE WATER RESOURCE MAPPING**

Groundwater Mapping helps to develop Groundwater availability maps, Pollution potential maps and Potentiometric surface maps. The ground water pollution potential mapping uses existing data to rank areas with respect to relative vulnerability to contamination from the surface. Ground water pollution potential maps may be used to assist planners, managers, and local officials in evaluating the potential for contamination from various sources of pollution. This

information can be used to help direct resources and land use activities to appropriate areas, or to assist in protection, monitoring and clean-up efforts.

Surface water mapping comprises collecting and generating information on the water resources at basin or regional level by compiling and storing precipitation, water storage, and stream flow data and compiling other hydrologic data. It uses stream gauging data and lake levels - low flow, high flow and points in between to estimate the water resource. Historic and current data will not only allow a wide range of private and public water users to reliably plan for and use the water resources, but also react to droughts.

Expected output

- Groundwater availability maps,
- Pollution potential maps,
- Potentiometric surface maps
- Surface water resource maps

Outreach

- Water source selection studies for
  - rural water supply and
  - micro irrigation schemes planning

Potential implementer

- Water sector organizations
- Local and international NGOs

Evaluation

- Extent of use of the maps for water resources investigation

• Geoid Determination

The definition of a high precision geoid is nowadays one of the most relevant tasks in Geodesy. A precise geoid estimate, in combination with satellite altimetry data, can give valuable information on ocean circulation and it is commonly used to get orthometric heights from GPS observations. The method for computing a high precision geoid, the so called "remove-restore" technique, has been critically revised in order to get a reliable estimation procedure.

Objective of the study

- The aim of this research is to improve the geoid undulation estimate in order to reach the one centimeter precision in dense gravity coverage in Ethiopia.

Expected output

- Estimate of the Ethiopian geoid, particularly Bahir dar area.
- to get centimeter accuracy we have to get gravity.

Theme 2: Disaster Risk Management and Food Security

- **CONFLICT HOT SPOT MAPPING**

Natural resources have become a fueling factor for conflicts in Africa. Other prevailing factors are also adding to the problem. According to the Intergovernmental Panel on Climate Change (IPCC), Africa's vulnerability arises from a combination of many factors, including extreme poverty, a high rate of population increase, frequent natural disasters such as droughts and floods, and agricultural systems (both crop and livestock production) that depend heavily on rainfall. The scarcity of natural resources is known to trigger competition for the meagre resources available among both individuals and communities, and even institutions, thus affecting human security on the continent. These resources may be categorized into four groups: land (including agricultural practices and animal stock), solid minerals, oil, and water. Water being used for immediate consumption by human and livestock and also drives the biological productivity of the area it represents the major factor. Thus it is vital to evaluate the availability of water and other resources driven by availability of water. Based on this rationale a GIS analysis will be made to map the potential conflict hotspots of the Nile Basin.

Expected output

- Locations of conflict hotspots in the Nile Basin
- Indicative underlying causes for conflict
- Proposed intervention measures

Outreach

- Preparation of conflict hotspot maps for decision makers in disaster prevention and preparedness office
- Starting the dialog for engagement with executing bodies for the implementation of mitigation measures

Potential implementer

- Disaster prevention and preparedness office
- Ministry of federal affairs

- Bahir Dar University

Evaluation

- Evaluating the contribution of the hotspot map implemented measures to the reduction of conflict in identified areas
- Evaluate how the research output had helped implementers in expediting their activities and optimizing their resources

• DROUGHT MONITORING

Drought is the single most important challenge in the Greater Horn of Africa. Disasters induced by drought account for about ninety percent of all disasters in the Region. Drought sets off a vicious cycle of socioeconomic impacts beginning with crop-yield failure, erosion of assets, decrease in income, worsening of living conditions, poor nutrition, and, subsequently, decreased coping capacity, and thus increasing vulnerability of the poor to another drought and other shocks as well as the risk of political instability and, in some cases, conflict. The situation is compounded by the long-term trends related to population growth and environmental degradation, coupled with other natural hazards. The combination of all of these factors turns shocks such as droughts and other type of hazards into catastrophic losses for the most vulnerable groups.

Drought is a slow-onset hazard, which provides time to consider and address its complex root causes, such as people's vulnerabilities and unsafe conditions related to poverty, fragile local economy, livelihoods at risk, lack of strategies and plans, limited institutional capacities and resources.

Geographic Information System and Remote Sensing Technology can be applied for disaster management, especially when it comes to disaster risk and exposure mapping. The conventional methods of drought assessment and monitoring efforts were laborious and time taking, in addition to reliability problem. Remote Sensing and GIS are proved to ease the situation in a better reliable and dependable system and outputs. Different indices are available to identify drought risk areas.

Knowing drought affected areas helps for decision about intervention and mitigation. The risk reduction and preparedness system needs timely information about the trend of risks and disasters in a specific area. GIS and Remote Sensing is proved to deliver time series assessment of drought risk areas. The research should consider important indices tested and proved to be fit in eastern African country. The resolution of time series image for this research should not be more than 1km.

Expected output

- Doughty risk areas of Amhara region identified and mapped
- Discrimination system of results indicated for remedial action
- Time series drought risks are identified
- Gauge based meteorological data compared with satellite NDVI Images.

Outreach

- Preparation of maps for Disaster Prevention and Food Security Co-Ordination Office for their decision support
- Starting to dialogue with Disaster Prevention and Food Security Co-Ordination officials and experts in seminar/s

Potential implementer

- ANRS Disaster Prevention and Food Security Co-Ordination Office
- ANRS Bureau of Agriculture
- BDU CAES, Department of DRMSD

Evaluation

- The result of the research will be evaluated by expert groups against its standard and truth on the ground.
- It will be evaluated whether it minimizes time, cost and labor

• PEST MONITORING

Plant diseases and pests can affect a wide range of commercial crops, and result in a significant yield loss. Locust outbreaks occur on all continents except Antarctica and can affect the livelihoods of one in 10 people on Earth. To prevent economic and environmental losses, locust breeding areas should be periodically monitored, and an early detection-early response strategy should be in place. Traditional, ground survey methods are inefficient to adequately address the large spatial scale of the locust problem.

Remote Sensing and the associated geospatial technologies can provide timely data to assess the risk of impending locust outbreaks. This information could be used for targeted preventive

management actions in the locust breeding areas. Remotely sensed data are used for monitoring habitats of certain species such as the Desert, Migratory and Australian Plague locusts. However, the vast potential of this technology remains untapped for other locusts. This chapter provides a review of remote sensing and GIS concepts, types of data collected by various remote sensing satellites, and applications of geospatial tools for locust habitat monitoring and risk assessment.

Locust outbreaks and subsequent destruction of vegetation result in ecological, environmental and economic problems. Locust swarms can devour green vegetation, including agricultural crops, across large geographic areas thereby upsetting the ecological processes (e.g. carbon and water cycles) of the region or any landscape.

Rapid loss in vegetation cover can result in soil erosion and increased run off. Crop damages could result in catastrophic losses to farmers, and this problem could be acute for small, subsistence farmers throughout the world and especially for those in developing countries.

Under the preventive mode, pest control specialists also need information on elevation (or topography), soil moisture, temperature and rainfall, in addition to the vegetation type, status and growth. Specialists use this information to set up effective surveys to assess pest egg-pod or nymphal distribution. During an outbreak, near real-time data on vegetation damage, and pest movement will be essential for assessing risks and prioritizing areas for curative treatments. Under either circumstance reliable methods are necessary for collecting information on vegetation status or assessing the damage to the native vegetation or crops resulting from pest outbreaks. Traditional, ground-based survey methods are inadequate to provide accurate and timely information about an ongoing locust outbreak and devise efficient management approaches, since some pest (e.g. locust hopper bands) move several km and swarms can travel up to 200 km in a day

Expected output

- Locations of potential pest breading sites

Outreach

- Training for agriculture bureau and ARBA professionals

Potential implementer

- BDU
- Bureau of Agriculture
- Disaster prevention and preparedness office

Evaluation

- Effectiveness of the method to monitor pest initiation and movement
- Accuracy of technique to map damages caused by pest
- Capability of professionals to monitor pest movement

- **LAND SLIDE MAPPING AND MONITORING**

Rapid and long traveling landslides trigger by earthquakes and rainstorm, especially those in urban area, have caused catastrophic or terrible disasters. To promote science and technology for landslide risk evaluation and mitigation especially for those catastrophic landslides, new geotechnical testing apparatuses including dynamic loading ring shear apparatuses and Gravimetry have been developed.

Landslide is reported to be one of the potential hazards in the highland Ethiopia. In north and south wollo, east and west Gojjam, south and north Gondar land slide have taken many lives. Therefore; mapping potential risk areas is very important for contingency planning and risk management.

Expected output

- mapping the potential site of Landslide case
- Modeling of the dynamic behavior of rapid landslides.
- Analysis of rock fall type and cause
- Rock fall risk assessment:

Outreach

- Studies of Mechanisms
- Mitigation of Landslide Hazards
- Evaluation and management of landslide risk
- Prediction of landslide occurrence time

Potential implementer

- Disaster Risk Management and Food Security Office and its line offices
- Bureau of Agriculture and its line offices

Evaluation

- Techniques and accuracy of the map

• Malaria Risk mapping

Each species of malaria have different behavioral pattern. Several species of *Anopheles* can be found in most malarial areas, and different species occur in different parts of the world. It burdens individuals and nations with substantial economic costs. This results in lower incomes for individuals and families and lower economic growth in malarious nations. Economists believe that malaria is responsible for a "growth penalty" of up to 1.3 percent per year in some African countries.

Malaria is seasonal in most parts of Ethiopia, with unstable transmission that lends itself to the outbreak of epidemics. The transmission patterns and intensity vary greatly due to the large diversity in altitude, rainfall, and population movement.

Amahra Region is one of the areas where malaria risk is the highest. Therefore, malaria control and prevention system should be aided with improved or new method which can alleviate this problem. Climatic and topography factors, particularly rainfall, temperature, altitude, and slope are known to have a strong influence on the biology of mosquitoes.

GIS and remote sensing can be used to associate variables and the distribution of mosquito responsible for malaria transmission. Other factors like population density, land-use/land-cover and proximity to different malaria causing or preventing factors can be also associated with the effect they do have on malaria prevalence using the same tools. Therefore, GIS and remote sensing are the appropriate tools to aid malaria control and prevention system through assessing potential malaria risk level of an area. With GIS and remote sensing it is possible to produce different thematic and attribute maps for each malaria supporting factors and malaria risk level for the study area. This in turn helps in the malaria control and prevention system of emergency response, preparedness, preventive measures, community awareness, identification of health facility accessibility and its location.

Expected outcome

- Map clearly identifying malaria risk areas with different levels of malaria risk

Outreach

  - Providing the map which clearly show malaria risk areas
  - Locating the level of risk

Potential implementer

- Bureau of health
- Individual and other organization working in this area.

Evaluation

- Methods applied and accuracy of the map

• FIRE RISK MAPPING

In a tropical country like Ethiopia farmers often ignite fire to clean their plots, thinking that the smoke will bring the rains and get rid of crop related diseases. In some areas farmers burn the natural vegetation in search or expansion of arable land. When those fires get out of control they often cause lot of damage to the ecosystem of the surrounding and may even harm human life and damage property. Extreme temperature sometimes becomes the cause for the start of the fire. Therefore, detection of the hotspot for fire outbreak is crucial in preparing the forest fire susceptibility map. Fires can be monitored and analyzed over large areas in a timely and cost effective manner by using satellite imagery. Also Geographical Information System (GIS) can be used effectively to demarcate the fire risk zone map. Factors that may be used as an input in preparing the fire susceptibility mapping may include vegetation, slope, aspect, distance to roads, distance to nearest water source and population density. The final output will rank each class with numerical weights that related to fire risk level.

Expected output

- Locations of regular fire occurrence
- Potential causes identified

Outreach

- Fire containment plan
- Training to professionals on fire monitoring

Potential implementer

- Forestry agency
- Disaster prevention and preparedness office
- City administrations and Municipalities

Evaluation

- Applicability of fire risk maps for monitoring fire incidences
- Capability gained by stakeholders

• Dust monitoring

Extreme aerosol events, such as dust storms, can produce large quantities of dust and haze dispersed over regional or global-scales. A dust storm (also called a sand storm) is a meteorological phenomenon that occurs frequently in arid and semi-arid regions. Dust storms arise when a strong winds blow loose sand and dirt particles off a dry surface. Particles are transported by saltation and suspension, causing soil to move from one place and be deposited in another. The Sahara and drylands around the Arabian Peninsula are the main sources of airborne dust.

A dark covering of haze probably a combination of dust and smoke is becoming familiar along the border between Sudan and Ethiopia. During the dry season the high over the Sahara and Arabian Peninsula intensify to Northern high lands of Ethiopia. When these highs are stronger than normal conditions the winds are strong and the general wind flow at the surface and low level is from northwesterly and northeasterly which are from dry air masses. The wind bring dust storm and reduce the surface horizontal visibility and flight visibility to less than normal from surface to some altitude over the north half of the country. Some dust blowing from Sudan reaches Lake Tana, in Ethiopia, in the upper right quadrant.

Remote Sensing data (ground-based and satellite) can be used to assess the frequency and magnitude of these dust events for potential impacts on climate, visibility and health-related air quality issues. In arid and semi-arid area of Asia, dust storms occur frequently.

Expected output

- Map of persistent sources of dust in the Blue Nile region
- Baseline for continued research in determining potential locations for future dust outbreaks

Outreach

- Awareness creation and capacity building

Potential implementer

- Disaster risk management and food security office and its stakeholders

Evaluation

- Effective identified dust storm hotspots and accuracy

Theme 3: Environmental monitoring and modeling

- **UTILITY MAPPING**

Often utilities are forced to rely on paper maps or basic aerial photographs to reference an infrastructure system. This method is of limited accuracy, nearly impossible to update, and does not take advantage of a variety of options offered by geographic information systems (GIS). A properly planned GIS-based infrastructure is an invaluable tool that:

- allows quick and easy infrastructure data access,
- reduces costs,
- eliminates database duplication, and
- enhances database standards & integrity.

Precision Geographic is experienced in assisting utilities in the conversion of infrastructure models into a geographic information system format including:

- water distribution
- sewage collection
- storm-water conveyance
- natural gas pipelines

The ability to access geographic information of infrastructure's features is essential to making decisions about billing, location of aging features, tracking of system maintenance, and planning for expansion.

Any attempt to improve, or even maintain, the standard of living in rapidly developing urban areas cannot go forward without adequate municipal infrastructure and utility services. Inadequate or poorly managed services limit urban economic development in several ways: exposing segments of the urban population to health risks; limiting economic productivity when services are cut-off or unreliable; adding financial costs to individuals and enterprises through unnecessary property damage; and creating additional economic costs from congestion of transportation and communications systems. The economic and efficient delivery of infrastructure services in turn, depends on effective planning and management. Without proper information, spatial and otherwise, the quality of service delivery, financial performance, and the ability to plan

can be eroded. Information from maps, and records, based largely on records of utilities and infrastructure facilities, contributes not only to efficient services, but also to the operation and maintenance of assets, and to the sensible planning of extensions and new works. Any serious lack of such information can adversely affect the economy, the quality of life, public health, and the environment.

Expected outputs

- database for utilities
- maps showing quick and easy access to infrastructures

Outreach

- capacity building
- database development
- data updating

Potential implementer

- City administration and municipality
- ANRS bureau of Water Resources Development

Evaluation

- Effectiveness of the database
- Completeness of infrastructure mapped

- **MONITORING WATER HYACINTH EXPANSION**

Eichhornia crassipes, commonly known as water hyacinth, is an aquatic plant native to the Amazon basin, and is often considered a highly problematic invasive species outside its native range. Due to the physical and ecological problems created by Water Hyacinth, fishers, boaters and swimmers are just a few of the groups that are significantly affected. Water Hyacinth degrades water quality, which reduces fishing opportunities. When Water Hyacinth takes over a water way, it limits the use and essentially makes it very difficult for boaters and swimmers. Also, when mats of Water Hyacinth are formed, underwater visibility and biodiversity is significantly compromised and SCUBA divers are unable to enjoy various underwater features.

Under favorable conditions, it forms dense mats over the surface of slow-moving waterways, including dams and reservoirs. Prolific growth can prevent recreational activities (such as swimming, boating, and fishing), block irrigation equipment, provide a habitat for mosquitoes, and displace native plants and wildlife. Enforced control is essential to prevent spread and to protect landholders in uninfested areas.

Recent observation over Lake Tana had indicated the spread of Water hyacinth. Water hyacinth has been described as the world's worst aquatic weed. When this exotic plant is introduced or colonizes a previously uninfested area, it may explode into large infestations causing serious disruption to environments, economies, and societies. Unmanaged water hyacinth populations create serious impacts that ripple through infested areas. These impacts include: impeding transport of irrigation and drainage water in canals and ditches; hindering navigation; interfering with hydroelectric schemes, increasing sedimentation by trapping silt particles, decreasing human food production in aquatic habitats (fisheries, crops); decreasing the possibilities for washing and bathing; and adversely affecting recreation (swimming).

The primary remote sensing task in mapping water hyacinth will be to discriminate it from other image constituents such as open water, land, waves, and other types of vegetation. To accomplish this, images of spaceborne and/or airborne sensors (e.g. Landsat TM, Radarsat, Landsat 7 ETM+ and others) may be employed.

The extent of water hyacinth can be inferred from satellite observation. The weed is observed in the rift valley lakes and Lake Tana in Amhara Region. The estimated area coverage of the weed in the Lake Tana was 40,000 hectares before two years.

Expected output

- Current extent of water hyacinth over Lake Tana
- Time series maps of water hyacinth
- Expansion trend of water hyacinth over the lake

Outreach

- Avail the up to date water hyacinth map of lake Tana to implementers

- Train ARBA professionals on water hyacinth mapping

Potential implementer

- Abay River Basin Authority
- ANRS bureau of Water Resources Development
- Bahir Dar University

Evaluation

- Evaluating the effect of the implemented measures to the reduction of sediment inflow into lake Tana

• Indexing sub-watersheds for their sediment contribution to a reservoir

Decision configuration of watershed management required scientific knowledge of resource information, expected sediment yield and priority class of watersheds for conservation planning. Satellite data is ideally suited to derive spatial & temporal information of watershed cover types which can be inputs to sediment yield model (s) & watershed prioritization scheme.

Basic technological ingredients to arrive at management decision by ascertaining scientific enquiries about where one should look-in for watershed conservation (critical watershed?, conservation priority?, how much money & effort to spend ?) can be best judged if we have the following information :

- Physical resources information of watershed.
- Modeling sediment yield from watershed.
- Prioritization of watershed for conservation planning.

In many instances in the past, non-availability of physical resources information of watershed was a major handicap in planning processes and management decisions.

Not all units (micro-, mini-, sub-watersheds) of a watershed contribute sediment yield & at the same rate. Identification of erosion-prone areas within a watershed or those sub-watersheds within a watershed which contribute maximum sediment yield obviously should determine our priority to evolve appropriate conservation management strategy

so that maximum benefit can be derived out of any such money-time-effort making scheme.

Expected output

- Catchment index in an order of their sediment contribution to Lake Tana

Outreach

- Preparation of implementation plan

Potential implementer

- Abay River Basin Authority
- Bureau of Agriculture
- ANRS bureau of Water Resources Development
- Bahir Dar University

Evaluation

- Evaluating the effect of the implemented measures to the reduction of sediment inflow into lake Tana

Theme 4: suitability analysis

- **CROP LAND SUITABILITY**

Crop-land suitability analysis is a prerequisite to achieve optimum utilization of the available land resources for sustainable agricultural production. Agricultural resources are considered to be one of the most important renewable and dynamic natural resources. Comprehensive, reliable and timely information on agricultural resources is very much necessary for a country like Ethiopia.

Identification of suitable land for certain type of crop is a key for successful crop production to feed millions of population particularly for developing countries like Ethiopia. Land use planning is largely dependent up on identification of suitable areas for crops that an area can grow. We know that in Ethiopia in a fragmented landholding system, farmers are growing different crops. Even though they do have life long experience, there should be scientific outputs supporting them for surplus production.

The suitable areas for agricultural use are determined by an evaluation of the climate, soil, and topographical environmental components and the understanding of local biophysical restraints. In this kind of situation, many variables are involved and each one should be weighted according to their relative importance on the optimal growth conditions for crops through analyzing a number of data in GIS.

Expected output

- Suitable areas for some specific crops are identified and mapped
- Scientific recommendations how to approach the farmers to introduce the results of the research.

Outreach

- Supporting the respective areas' agriculture office in land use planning in a given watershed.

Potential implementer

- BDR university CAES, department of plant sciences.
- Regional bureau of agriculture and woreda office of agriculture.

Evaluation

- The result of the research would be evaluated based on its applicability at the ground.
- It will be evaluated whether it considers most important parameters and analyze in an appropriate manner.

• APPLICATION OF GIS AND REMOTE SENSING TECHNOLOGY IN TOURISM DEVELOPMENT

GIS and remote sensing technologies can support sustainable tourism development. Hence, tourism planning can be enhanced by GIS applications. GIS can be regarded as providing a toolbox of techniques and technologies of wide applicability to the achievement of sustainable tourism development. Tourism sector has increased over the recent years. The tourist potential in the future is expected to increase by the current scenario and existing tourism potential has to be investigated.

GIS is used for managing intensive information needed in tourism business, estimating indicators, and generally assisting decisionmaking in the phases of planning, monitoring and eval uation. However, the number of GIS applications forsustainable tourism development has not flourished as in other fields. Tourism management and planning have a lot to benefit from using GIS technology. Some of the key features of GIS that could benefit tourism planning include their ability to control spatial data and provide necessary value added information.

Supporting sustainable tourism development, GIS can provide a unified tourism information network on varieties of data. For example, it includes maps of and information on geographical locations, topography, infrastructure, superstructure and kinds of heritage and tourist attractions available. The technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps. It gives users the opportunity to integrate a wide range of different data and, more importantly, allows non-specialists to carry out sophisticated queries.

Tourism marketing is another branch of tourism that benefits from GIS applications. Map-based information for tourists that may be found on the web is a quite popular application of GIS. An

ever-increasing number of destinations are being promoted via the internet; map-based information is used in many cases.

Expected output

- Attractive tourist map which can be used for self help
- Database for potential tourist sites in the study area.

Outreach

- Preparing the main guideline for tourist industry
- Capacity builduing
- Locating exact tourist sites appropriately attract and generate income for the region and the country.

Potential implementer

- Beauro of culture, tourism and parks development
- Hotels
- Touring agents and others

Evaluation

- Evaluating the contribution of selected tourist sites for income generating to the region and benefits to local community
- Evaluate how developed tourist guide is contributing to the community